Project Number: 5430-44000-024-00D **Accession:** 0419827 **FY:** 2011

ModeCode: 5430-05-10 NORTHERN PLAINS AREA
MANHATTAN, KANSAS
CENTER FOR GRAIN AND ANIMAL HEALTH RESEARCH
GRAIN QUALITY AND STRUCTURE RESEARCH

NPL Leader: ROBERT L FIREOVID **Prin Invs:** MICHAEL TILLEY

Start Date: 07/01/2010 **Term Date:** 06/30/2015

National Programs: 306 N Quality and Utilization of Agricultural Products

Title: BIOCHEMICAL AND PHYSICAL CHARACTERIZATION OF HARD WINTER WHEAT QUALITY FOR END-USE QUALITY

Period Covered **From:** 10 / 2010 **To:** 9 / 2011 **Final Report?** No
Terminate in Two Months? No

Progress and Outcomes:

4. Accomplishments

01 Objective methods to predict tortilla quality. Currently, the suitability of wheat lines for tortilla production is done by milling the wheat, evaluating the flour and processing it into tortillas. Moreover, it requires at least 1 kg of flour to do all of the tests. This makes screening wheat lines developed by breeders time-consuming, labor-intensive and costly. Developing prediction methods is one approach to make this screening process more efficient. ARS researchers at Manhattan, KS, developed models to predict tortilla diameter from any given flour from the mixing time and dough resistance to extension values and insoluble flour protein. A strong negative correlation between flour insoluble protein content and tortilla quality substantiates that flour properties required for good quality tortillas and breads are quite different and thus research continues to define the flour parameters for tortilla quality. These prediction models will be an easy and fast tool for breeders to advance or eliminate wheat lines specifically to breed for tortilla production.

306 1 A 2010

02 Dissecting the genetic basis of bread making quality. The effect of different wheat flour proteins on bread-making properties is poorly characterized, particularly in U.S. breeding programs. ARS researchers at Manhattan, KS, evaluated mixing properties and protein composition of a set of 424 advanced hard winter wheat lines that represent the variability of the current hard winter wheat within the Great Plains. They showed that a particular combination of proteins had a significant effect on mixing time - some were associated with longer mix times, while others were associated with shorter mix times. Being able to identify the effects of variation in wheat storage proteins on dough properties and end products will definitely be of benefit not only to the breeding community, but also provide key insight to the keys for quality.

306 1 A 2010

Project Number: 5430-44000-022-00D **Accession:** 0418407 **FY:** 2010

ModeCode: 5430-05-10 NORTHERN PLAINS AREA
MANHATTAN, KANSAS
CENTER FOR GRAIN AND ANIMAL HEALTH RESEARCH
GRAIN QUALITY AND STRUCTURE RESEARCH

NPL Leader: LEWIS FRANKLIN FLORA **Prin Invs:** BRADFORD W SEABOURN

Start Date: 10/01/2009 **Term Date:** 06/30/2010

National Programs: 306 N Quality and Utilization of Agricultural Products

Title: ENHANCEMENT OF HARD WINTER WHEAT QUALITY AND ITS UTILITY

Period Covered **From:** 10 / 2009 **To:** 9 / 2010 **Final Report?** Yes
Terminate in Two Months? No

Progress and Outcomes:

4. Accomplishments

01 Improved protein characterization method. The objective of this study was to investigate if a narrow-bore column improved analyses of unreduced proteins in flour by size exclusion chromatography and subsequent evaluation of bread-making quality of wheat flours. Various extractable and unextractable wheat proteins were analyzed by ARS scientists in Manhattan, Kansas. The narrow column separated proteins in 10 min with similar resolution to a regular (larger) column which took 30 min. This new technique showed comparable or superior repeatability and correlations with flour bread-making characteristics when compared with those of a regular column. Unextractable proteins showed greater repeatability and correlation with quality characteristics than those of actual total protein extracts. The improvements, including employment of a narrow column, provide enhancement of rapid quality evaluation and decreased consumption of hazardous organic solvents.

306 1 A 2000

02 Protein quality in waxy wheat. The objective of this study was to evaluate protein composition and its effects on flour quality and physical dough test parameters using waxy wheat near-isogenic lines. Partial waxy and waxy lines of bread wheat and durum wheat were investigated by ARS scientists in Manhattan, Kansas. In terms of protein composition, waxy wheats used in this study were found to have relatively lower albumins/globulins than the hard winter wheat control. Dough strength as measured by mixograph and extensibility was correlated only moderately with unextractable polymeric protein. This may be due to the lack of dough strength contributing subunits such as 5+10 and the occurrence of 2+12. A moderate positive correlation of extensibility and a highly positive correlation of loaf volume to flour polymeric protein was found. Loaf volume was also correlated with percent polymeric protein, which indicated that this aspect of end-use functionality is significantly influenced by polymeric proteins in these waxy wheat lines. High loaf volume was observed with 100% waxy wheat flour alone and was not improved with 50% blending with commercial bread wheat flour. However, dark color and poor crumb structure was observed with 100% waxy flour, which is unacceptable to consumers.

306 1 A 2000

03 Evaluation of experimental breeding lines and released wheat cultivars. 1) More than twenty advanced breeding lines and their checks used as controls for their breeding programs were submitted to the Hard Winter Wheat Quality Lab (HWWQL) by public and private breeders from the Great Plains for evaluation. A technical report prepared by the HWWQL was reviewed and discussed by participants from all sectors of wheat industry at the annual Wheat Quality Council conference meeting. 2) Approximately 15 to 20 predominantly hard winter wheat cultivars grown in the Great Plains were submitted to the HWWQL for evaluation by participating states (TX, OK, KS, CO, NE, SD, and MT) for the Overseas Varietal Analysis (OVA) project administered by U.S. Wheat Associates. More than 20 overseas collaborators in 15 to 18 countries performed end-

Project Number: 5430-44000-022-00D **Accession:** 0418407 **FY:** 2010

product quality tests specific to their needs. The HWWQL prepared a final and comprehensive technical report that was published by U.S. Wheat Associates and distributed to the U.S. hard winter wheat industry and the overseas collaborators. 3) The HWWQL evaluated experimental breeding lines in the USDA hard winter wheat regional performance nurseries (RPN). The test results were compiled, published, and distributed to U.S. wheat breeders to determine the quality performance of their entries under the influence of different geographical locations. 4) The HWWQL evaluated more than 500 individual samples and 100 composites from the hard winter wheat growing region as harvest progressed. The test results were updated weekly on the U.S Wheat Associates webpage. These results allow domestic and international wheat buyers to obtain information on the quality of the new crop as soon as possible.

306 1 A 2000

Project Number: 5430-44000-020-00D **Accession:** 0418405 **FY:** 2010

ModeCode: 5430-05-10 NORTHERN PLAINS AREA
MANHATTAN, KANSAS
CENTER FOR GRAIN AND ANIMAL HEALTH RESEARCH
GRAIN QUALITY AND STRUCTURE RESEARCH

NPL Leader: LEWIS FRANKLIN FLORA **Prin Invs:** MICHAEL TILLEY

Start Date: 10/01/2009 **Term Date:** 06/30/2010

National Programs: 306 N Quality and Utilization of Agricultural Products

Title: CHARACTERIZATION OF GRAIN BIOCHEMICAL COMPONENTS RESPONSIBLE FOR END-USE QUALITY

Period Covered **From:** 10 / 2009 **To:** 9 / 2010 **Final Report?** Yes
Terminate in Two Months? No

Progress and Outcomes:

4. Accomplishments

01 Starch size distribution has an effect on bake quality of hard red winter wheat. Starch was isolated from growing season 2007 and 2008 of six hard red winter wheat established lines in two dryland growing conditions and one irrigated regime. Starch size distribution was correlated to bake quality, as well as bake quality to location grown. Using laser diffraction sizing, ARS scientists at Manhattan, Kanasas demonstrated at 10-20 µm starch size distribution in year 2007 had slightly negative correlations to bread crumb values; slice brightness, crumb cell number, cell wall thickness and cell diameter. When bake data was pooled together by variety, the irrigated location had a substantial increase in loaf volume when compared to the dryland grown varieties. The bake data has not been completed as yet for 2008 growing season. Progress made in correlating starch properties to bread baking parameters provides important information for developing models to predict wheat quality. This information is critical in determining the effect growing conditions have on wheat quality. While the baking industry has always been interested in protein quality/quantity in producing quality products, starch size distribution ratios also plays a critical role in bread systems.

306 1 A 2000

02 The environment effects hard red winter wheat starch size distribution. Genetics is the primary determinate in the expression of traits with regard to wheat and its quality. Environmental factors can at times play a primary role in how those genetic traits are expressed. Consequently it is important to examine growing location, water availability, soil and air temperature, humidity, and transpiration rates when determining wheat quality parameters. ARS scientists in Manhattan, Kansas evaluated hard red winter wheat starch size distribution from 2007 (6 varieties) and 2008 (5 identical varieties from 2007), from three different locations (two dry land and one irrigated growing regimes). Correlation statistics regarding size distribution indicate significant differences in most variables with regard to year, location and variety. More sophisticated statistical analysis such as step wise regression and/or principle component analysis, including weather information from each location, is being used to segregate events or factors responsible for variability in starch size distribution. This information is important for identifiying environmental factors effecting starch quantity and quality and provides a basis for predicting the impact of flour and starch size distribution on end-use quality.

306 1 A 2000

Project Number: 5430-44000-016-00D **Accession:** 0408487 **FY:** 2009

ModeCode: 5430-05-10 NORTHERN PLAINS AREA
MANHATTAN, KANSAS
CENTER FOR GRAIN AND ANIMAL HEALTH RESEARCH
GRAIN QUALITY AND STRUCTURE RESEARCH

NPL Leader: LEWIS FRANKLIN FLORA **Prin Invs:** MICHAEL TILLEY

Start Date: 10/01/2004 **Term Date:** 09/30/2009

National Programs: 306 N Quality and Utilization of Agricultural Products

Title: CHARACTERIZATION OF GRAIN BIOCHEMICAL COMPONENTS RESPONSIBLE FOR END-USE QUALITY

Period Covered **From:** 10 / 2008 **To:** 9 / 2009 **Final Report?** Yes
Terminate in Two Months? No

Progress and Outcomes:

4. Accomplishments

01 Effects of tortilla processing on protein and starch: Samples were collected at multiple time points during tortilla processing and prepared for protein and starch analysis. Size exclusion HPLC derived from soluble protein fractions revealed protein polymerization as dough was formed. Subsequently, the extractability of soluble proteins (monomeric and soluble polymeric) decreased gradually as dough was transformed into tortillas by hot-pressing and baking. No differences were detected in protein samples isolated from tortillas at days 0, 2 and 7, indicating that changes in protein structure occurred during mixing and baking only. Insoluble proteins were extracted by a reducing agent and chromatograms revealed a gradual increase in total peak area as tortillas were processed. An increase in soluble starch was detected during processing. However, the results revealed a 32% decrease in soluble starch during storage. All together, data presented here indicates that proteins undergo structure changes via formation of larger protein polymers through disulfide cross-links, and starch gelatinizes during baking and retrogrades during storage.

306 1 A 2000
306 1 B 2000
306 1 C 2000

Project Number: 5430-44000-016-00D **Accession:** 0408487 **FY:** 2008

ModeCode: 5430-05-10 NORTHERN PLAINS AREA
MANHATTAN, KANSAS
CENTER FOR GRAIN AND ANIMAL HEALTH RESEARCH
GRAIN QUALITY AND STRUCTURE RESEARCH

NPL Leader: LEWIS FRANKLIN FLORA **Prin Invs:** MICHAEL TILLEY

Start Date: 10/01/2004 **Term Date:** 09/30/2009

National Programs: 306 N Quality and Utilization of Agricultural Products

Title: CHARACTERIZATION OF GRAIN BIOCHEMICAL COMPONENTS RESPONSIBLE FOR END-USE QUALITY

Period Covered **From:** 10 / 2007 **To:** 9 / 2008 **Final Report?** No
Terminate in Two Months? No

Progress and Outcomes:

4. Accomplishments

01 Environmental events affecting starch size distribution in developing hard red winter wheat caryopsis: Starch constitutes the greatest weight portion of the wheat endosperm (65-75%) and contributes its own unique functional qualities such as texture, volume, consistency, aesthetics, moisture, and shelf stability to various baked products. Starch particle size has long been recognized as an important variable in the efficiency of a range of processes including predicting rheology and flow behavior. While genetics is the dominant determinant in caryopsis development the environment also has a critical role in quality variability. The objective of this work is to study starch size distribution in identical varieties of developing hard red winter wheat grown in the same location over 7 consecutive years and correlate differences to various environmental factors. The samples were collected from the Kansas State University Agronomy field plots in Manhattan, KS. The heads were tagged as to flowering dates and samples were collected starting at 7 days-after-flowering (DAF) and regularly sampled until harvest. The starch was isolated, then freeze-dried and starch size distribution was analyzed on a laser diffraction particle size analyzer. Trends were observed within varieties between starch size distribution and temperature as well as total precipitation in 10, 17, 28 DAF and just prior to harvest. These trends included total volume fluctuations and shifts in peak diameters of 10-20% of the A-type granules. Studying starch size distribution during development of the wheat caryopsis may provide needed insight into critical environmental growth phases. This accomplishments falls under the National Program 306 "Quality and Utilization of Agricultural Products", specifically on component 1 "Quality Characterization, Preservation and Enhancement." Multiple Problem Areas of this component are directly addressed in the objectives -- Problem Areas 1a, 1b and 1c.

02 Identification of protein expression on tortilla quality:
The wheat tortilla is a chemically leavened circular light colored flat bread. Desirable characteristics for good quality tortilla include large diameter, softness, flexibility and long shelf stability. Important components influencing quality are wheat flour properties, which have not been optimized for tortilla industrial production thus far. The objective of this research was to determine the effects of over-expression of high molecular weight glutenin subunits (HMW-GS) 10 on tortilla quality. Analysis of protein expression and protein extractability were conducted to characterize wheat flours. Dough properties were determined. Tortillas were prepared by the hot-press method and quality parameters were measured. Tortillas derived from transgenic flours over-expressing HMW-GS 10 exhibited an undesirable appearance with decreased diameter, greater thickness and rupture force, lower rollability scores and stretchability. Over-expression of HMW-GS 10 in a wheat line containing 1RS-translocation did not promote the same deleterious effects in tortilla quality as it did in transgenic lines without 1RS translocation. This accomplishments falls under the National Program 306 "Quality and Utilization of Agricultural Products”, specifically on component 1 “Quality Characterization, Preservation, and Enhancement”.

Project Number: 5430-44000-016-00D **Accession:** 0408487 **FY:** 2008

Multiple Problem Areas of this component are directly addressed in the objectives -- Problem Areas 1a (Definition and Basis for Quality); 1b (Methods to Evaluate and Predict Quality) and 1c (Factors and Processes that Affect Quality). The elucidation of fundamental biochemical processes and their role in determining product quality is paramount for the development of accurate methods for quality measurement.

03 Effects of environment on starch size distribution of Canadian wheat varieties: This study was done in collaboration with the University of Manitoba. Large qualities of starch were isolated from ~350 established Canadian wheat varieties grown throughout the country. Detailed environmental data has been compiled to correlate starch size distribution to various quality parameters. Laser diffraction starch size distributions were collected in duplicate to incorporate into a “G X E quality model system”. The data is currently being incorporated into the model, we expect to get a more complete picture of how the environment affects wheat quality, specifically the quality of starch. This accomplishment falls under the National Program 306 "Quality and Utilization of Agricultural Products”, specifically on component 1 “Quality Characterization, Preservation, and Enhancement”. Multiple Problem Areas of this component are directly addressed in the objectives -- Problem Areas 1a (Definition and Basis for Quality); 1b (Methods to Evaluate and Predict Quality) and 1c (Factors and Processes that Affect Quality). The elucidation of fundamental biochemical processes and their role in determining product quality is paramount for the development of accurate methods for quality measurement.

Project Number: 5430-44000-016-00D **Accession:** 0408487 **FY:** 2007

ModeCode: 5430-05-10 NORTHERN PLAINS AREA
MANHATTAN, KANSAS
CENTER FOR GRAIN AND ANIMAL HEALTH RESEARCH
GRAIN QUALITY AND STRUCTURE RESEARCH

NPL Leader: LEWIS FRANKLIN FLORA **Prin Invs:** MICHAEL TILLEY

Start Date: 10/01/2004 **Term Date:** 09/30/2009

National Programs: 306 N Quality and Utilization of Agricultural Products

Title: CHARACTERIZATION OF GRAIN BIOCHEMICAL COMPONENTS RESPONSIBLE FOR END-USE QUALITY

Period Covered **From:** 10 / 2006 **To:** 9 / 2007 **Final Report?** No
Terminate in Two Months? No

Progress and Outcomes:

4. Accomplishments

4a. QUALITY OF SPELT WHEAT AND ITS STARCH
Spelt is the only husked wheat that is currently grown in the United States for human food consumption. Market promotions for human consumption increased from less than 40 ha to over 3200 ha between 1987 and the present. Spelt products are available through health food outlets as grain, whole grain and white flours and processed products. These products include assorted pasta, cold and hot cereals, and pre-packaged bread, muffin, and pancake mixes. Spelt in the United States remains a commodity in the health food and specialty markets with limited crop production. While the gluten fraction of spelts has received most of the attention with respect to its possible unique products and functionality, the starch fraction has received little attention. This study assessed the composition and properties of flour and starch from five spelt varieties grown in the same location over three growing seasons. Our correction model for starch size distribution by laser diffraction particle sizing was used to develop some of the correlations in this study. The environment impact on spelt properties seemed to have a greater effect on bread baking quality and various starch properties than genetic control.

4b. THE ENVIRONMENTAL IMPACT ON WHEAT STARCH SIZE DISTRIBUTION DURING GRAIN FILLING.
The environmental impact on the starch size distribution during grain filling of hard red winter wheat has been collected and collated. These samples were all grown at the the Kansas State University Agronomy Study plots over a 6 year period of time. Statistical analysis of this data is nearing completion and correlations to some weather conditions have been noted. The larger starch size distributions (everything > 20 µm) are positively correlated to increased cumulative precipitation, while the 5-20 µm starch size distributions are negatively correlated to decreased cumulative precipitation and decreased cumulative and average evapo-transpiration rates. Decreasing soil and air temperatures also appear to have a negative correlation to the 5-20 µm starch populations, while increasing soil and air temperatures has a positive correlation to the 20-30 µm starch populations.

4c. THE EFFECT OF THE ENVIRONMENT ON STARCH SIZE DISTRIBUTION OF CANADIAN WHEAT VARIETIES.
This study was done in collaboration with the University of Manitoba. Large qualities of starch were isolated from ~350 established Canadian wheat varieties grown throughout the country. Detailed environmental data has been compiled to correlate starch size distribution to various quality parameters. Laser diffraction starch size distributions were collected in duplicate to incorporate into a “G X E quality model system”. The data is currently in the analysis phase but soon we expect to get a more complete picture of how the environment affects wheat quality, specifically the quality of starch.

4d. IDENTIFICATION OF PROTEIN COMPOSITION FOR IDEAL TORTILLAS:

Project Number: 5430-44000-016-00D **Accession:** 0408487 **FY:** 2007

The tortilla industry is one of the fastest growing segments of the U.S. baking industry with annual sales surpassing $6 billion. Flour used in tortilla production has been typically optimized for bread making and thus the flour properties that determine good quality bread do not necessarily provide good quality tortillas. The results indicated better tortillas with a longer shelf-life were obtained with higher protein content flours containing HMW-GS 5+10. This data will allow wheat breeders to target the characteristics for development of tortilla or multi-use wheat lines and decrease the addition of additives to adjust flour quality in the tortilla industry.

All of these research accomplishments fall under the National Program 306 "Quality and Utilization of Agricultural Products”, specifically on component 1 “Quality Characterization, Preservation, and Enhancement”. Multiple Problem Areas of this component are directly addressed in the objectives -- Problem Areas 1a (Definition and Basis for Quality); 1b (Methods to Evaluate and Predict Quality) and 1c (Factors and Processes that Affect Quality). The elucidation of fundamental biochemical processes and their role in determining product quality is paramount for the development of accurate methods for quality measurement.